Free falling smartphones: evaluation of a practical experience

Anna R. ESTEVE, Aina BENAVENT, Jordi SOLBES

Dpto. Didáctica de las Ciencias Experimentales y Sociales, Universidad de Valencia, Avda. Tarongers, 4, 46022, Valencia, Spain

Abstract. In order to check if the students' learning about free fall improves by performing a practical experience with smartphones, one has been designed and evaluated with a pre-post questionnaire. This questionnaire was filled in by 26 students enrolled in the "Physics and Chemistry" course of the fourth year of compulsory high school (ages 15 to16). The analysis of the answers given by the students in the pre-post questionnaire shows that the observed differences between them are significant, thus showing that the proposed practical experience helps to improve the students' learning about free fall.

1 Introduction

Physics teachers can use the interest of their students in smartphones and/or tablets, and take advantage of the sensors (accelerometer, gyroscope, light detector, etc.) these devices are equipped with to propose experiments that use them as measurement tools both in teaching laboratories and in everyday activities in order to increase the motivation of their students [1]. Besides, the use of smartphones allows having teaching laboratories that are less expensive, but also allows students to make measurements outside the laboratory during their daily activities, where they can apply what they learn in class [2]. Thus, students can realize that what they learn in class is part of their everyday life [3].

In this work, a practical experience about free falling objects involving the use of smartphones was designed based on that proposed by [4, 5]. The main objective of this experience was to help students deal with alternative conceptions of free fall and understand better the concepts related with this motion. Moreover, an evaluation of this practical experience was conducted with a pre-post-design in order to evaluate to what extent it helped to improve the students' learning about free fall.

2 Method

The practical experience with smartphones about free fall was performed in 2 sessions of 1 hour each. During the first session, the basic concepts related with this motion were reviewed, students hypothesized about how free falling objects would move, and made measurements with their smartphones. During the second session, students analyzed their measurements with the help of a computer and a group discussion about the results was held.

The designed pre-post questionnaire to evaluate if the students' learning about free fall improves by performing this practical experience with smartphones has six short free-response questions: two questions about alternative conceptions, two questions about concepts, one question about applying the methods learned during the experience, and one question about the students' knowledge of real applications of this motion. The students' responses in the pre-post questionnaire were classified in three categories: correct, partially correct, and incorrect. This questionnaire was filled in by 26 students enrolled in the "Physics and Chemistry" course of the fourth year of compulsory high school (ages 15 to 16) from one school in the province of Valencia (Spain).

3 Results and Discussion

Figure 1 shows the answers given by the students in the pre-post questionnaire. For the questions about alternative conceptions (Q1 and Q2), there are only correct and incorrect answers, and the number of incorrect ones substantially decreases in the post-test while increasing the number of correct ones. For the questions about concepts (Q3 and Q4), the decrease in the number of incorrect answers in the post-test is also substantial, with most of them changing to correct answers and few to partially correct answers. For the questions about the applications of the experience's methods (Q5) or free fall (Q6), the decrease in the number of incorrect answers in the post-test is again substantial, although now more of them change to partially correct answers.

Since the answers given by the students are paired samples (pre-post questionnaire) that do not follow a normal distribution (according to the Shapiro-Wilk test), the Stuart-Maxwell test of marginal homogeneity has been used to determine that the observed difference between them is significant (p-value < 0.05 for every question).

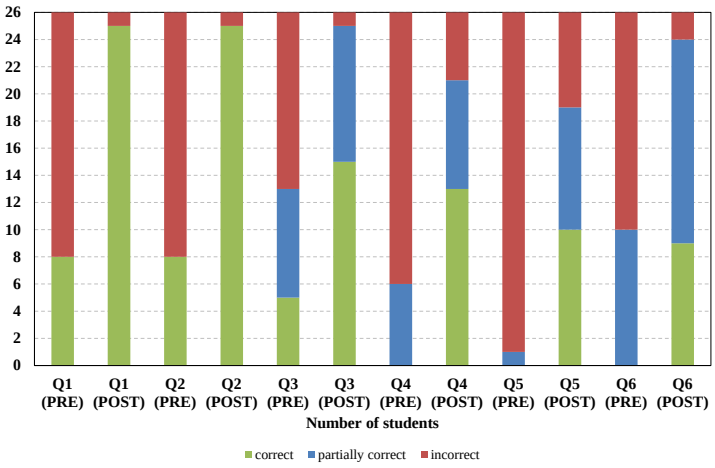

Fig. 1 Answers given by the students in the pre-post questionnaire.

4 Conclusion

The evaluation of the proposed practical experience with smartphones shows that it helps to significantly improve the students' learning about free fall. However, further research is still necessary (e.g., more participants of different ages are needed to fill in the pre-post questionnaire).

Acknowledgements

This research was financed jointly by the Spanish Ministry of Economy and Competitiveness and the European Regional Development Fund through the project EDU2015-69701-P.

References

[1] J. Kuhn and P. Vogt, Smartphones as experimental tools: Different methods to determine the gravitational acceleration in classroom physics by using everyday devices, *EJPE*, **4** (2013), 16-27.

[2] M.A. González, M.A. González, M.E. Martín, C. Llamas, O. Martínez, J. Vegas, M. Herguedas and C. Hernández, Teaching and Learning Physics with Smartphones, *J. Cases Inf. Technol.*, **17** (2015).

[3] O.R. Lozano and J. Solbes, *85 experimentos de física cotidiana*, Graó, Barcelona, 2014.

[4] P. Vogt and J. Kuhn, Analyzing free fall with a smartphone acceleration sensor, *The Physics Teacher*, **50** (2012), 182-183.

[5] S. Gil and J.L. Di Laccio, Smartphone una herramienta de laboratorio y aprendizaje: laboratorios de bajo costo para el aprendizaje de las ciencias, *Lat. Am. J. Phys. Educ.*, **11** (2017), 1305-1913.